

## Notes on *Boloria pales yangi*, ssp. nov., a remarkable disjunction in butterfly biogeography (Lepidoptera: Nymphalidae)

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**Abstract.** A population of *Boloria pales* (Denis & Schiffermüller) was found at an alpine area in Taiwan, far away from the nearest population in western China and farther south than any previous record of the genus *Boloria*. The taxon is considered a new subspecies and is described herein.

**Key Words.** *Boloria pales*, disjunction, biogeography, Taiwan, China

### INTRODUCTION

The genus *Boloria* (sensu Scott 1986, D'Abrera 1992) is composed of approximately 30 species of small nymphalids favoring either damp and wet habitats or rocky slopes (Shepard 1975), distributed in boreal and arctic parts of the Holarctic region. The recognized southernmost limit of this genus was 30° N for *B. pales* (Denis & Schiffermüller) in the Palaearctic (BMNH specimens) and 35° N for *B. chariclea* (Esper) in the Nearctic (Scott 1986).

Two male specimens of this genus were collected by Prof. C.T. Yang from an alpine area in the central part of Taiwan at approximately 24° N. These specimens represent the first record of *Boloria* outside the Holarctic, and are herein classified as a subspecies of *B. pales* (Denis & Schiffermüller). This discovery is significant for three reasons: 1) This is unquestionably the southernmost record for the genus and the first record of *Boloria*, a typical Holarctic genus, in the Oriental region. 2) The closest *B. pales* colony to Taiwan is found in the Sichuan province of western China, about 2000 km distant (Fig. 1). This large disjunction suggests that the Taiwan population is a relict left from a glacial period of the Pleistocene. 3) It is striking that such a unique species has been found in a well-collected island.

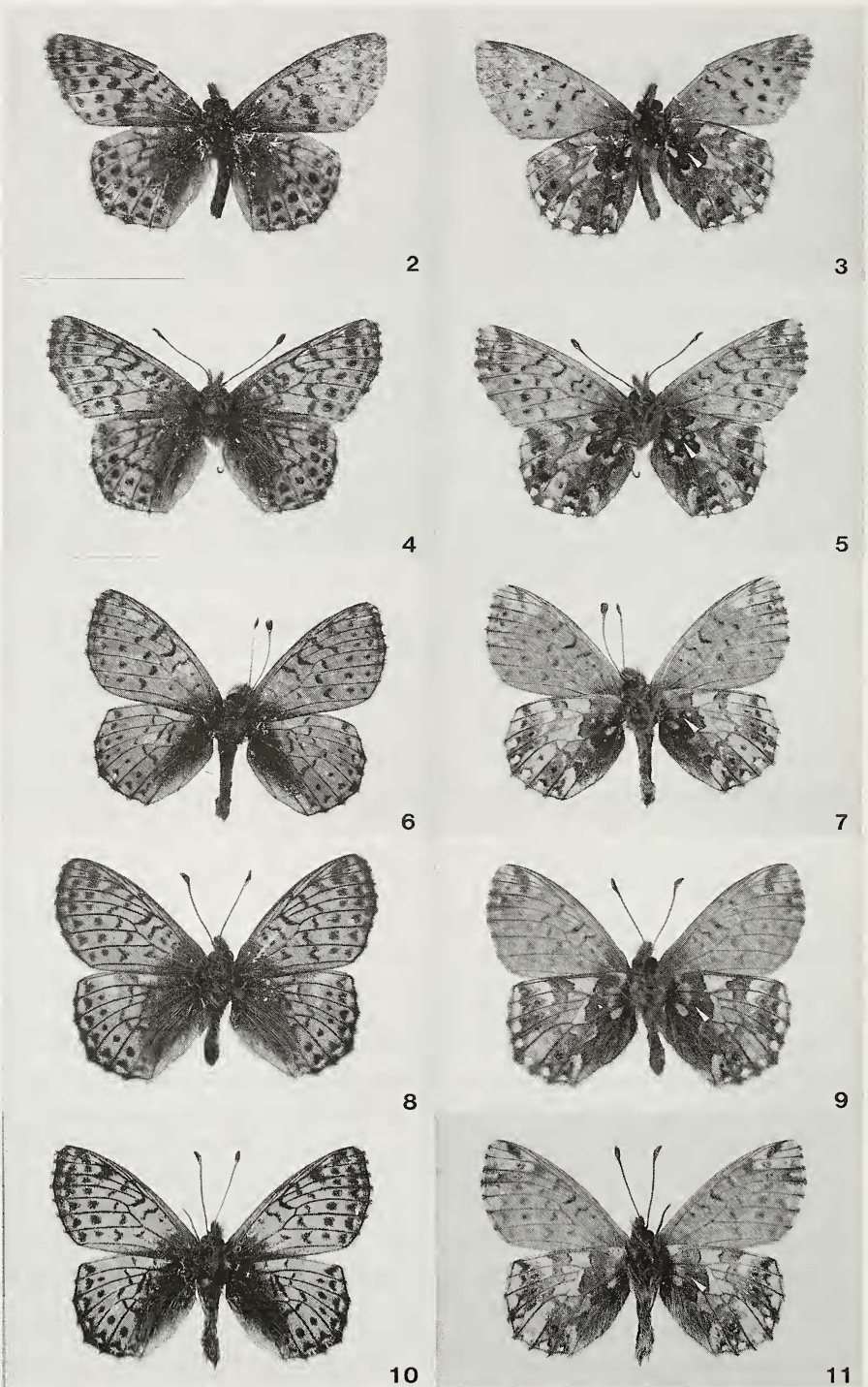
The specimens from Taiwan most closely resemble *B. pales palina* Fruhstorfer in western China, but has distinctive characters on wing patterns and male genitalia. We describe these specimens as a new subspecies here.



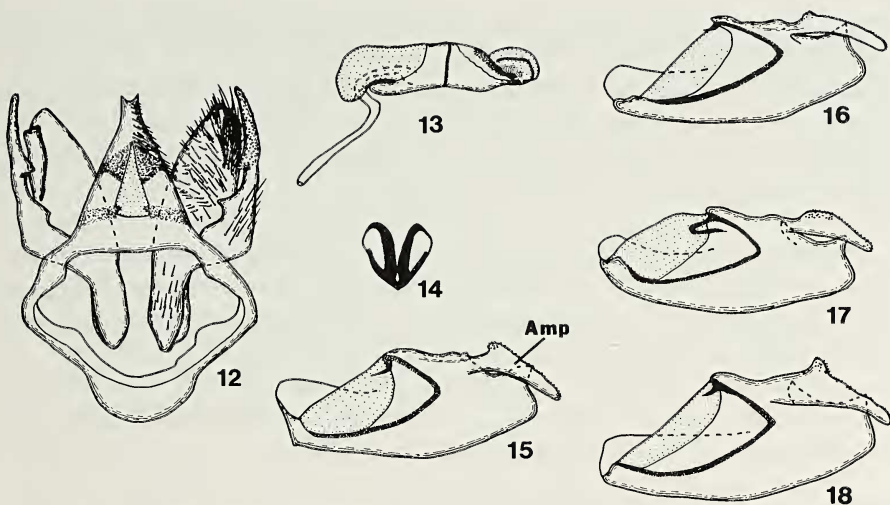
Fig. 1. Known geographical distribution of *Boloria pales* in East Asia and neighboring areas; squares denote confirmed sites from specimens examined from BMNH, NCU, and NTU; circles represent province records based on BMNH specimens.

*Boloria pales subspecies yangi* Hsu & Yen, **ssp. nov.** (Figs. 2, 3, 12–15)

**Male.** Forewing length 18.0 mm ( $n = 2$ ). Head: hairy, covered with buff orange hairs on vertex and frons. Eyes semi-oval, naked. Labial palpus hairy, porrect, pointed, yellow proximally, buff orange distally. Thorax: black, covered with pale buff orange hairs. Legs hairy, buff orange. Forewing: termen slightly concave. 12 veins, R1 independent, other R veins all extending from Rs. M2 slightly bent toward M1; base of M3 strongly curved posteriorly. Upperside color pale buff orange with pale black markings. Six black, round postdiscal spots with posterior three indented. Submarginal spot black, prominent, fused with postdiscal spot series anteriorly. Marginal markings obscure. Discal spots prominent, wider than postdiscal spots. Black markings in discoidal cell composed of a distal bar, a medial bar, and two proximal dots. Basal area covered by extensive pale black scaling. Underside pale buff with pale black markings. Cinnamon-rufous bar edged by creamy yellow patches present near apex. Fringe uniformly orange. Hindwing: nine veins, all separate. M3 bent near base. Humeral vein a short bar, perpendicular to Sc + R1. Upperside pale buff orange with pale black markings. Six round postdiscal spots arranged into an arch. Submarginal spot series prominent, triangular. Marginal markings more prominent than forewing. Discal spots narrow. Basal area with extensive pale black scaling extending distally covering distal end of discoidal cell and discal band in



Figs. 2–11. *Boloria* specimens. 2–9: *Boloria pales* from various geographical regions. 2, 3) Taiwan; 4, 5) Sichuan, western China; 6, 7) Kazakhstan; 8, 9) Southwestern France. 10, 11) *Boloria napaea* from Switzerland.



Figs. 12–18. Male genitalia of *Boloria* specimens. 12–15: *Boloria pales yangi* Hsu & Yen. 12) Tegumen + valvae, dorsal view; 13) Phallus, lateral view; 14) Juxta, posterior view; 15) Left valva. 16–18: Left valva of *Boloria pales* from various geographical regions. 16) Sichuan, western China; 17) Kazakhstan; 18) southwestern France. “Amp” denotes ampulla.

Cu cells. Underside coloration variegated. Basal area cinnamon-rufous surrounded by three silvery white lunules. Single prominent silvery white dot present at base of cell Cu2; another small silvery white dot in discoidal cell. Discal area forming a tawny band unevenly delimited distad by short black lines. Yellow scalings present in anterior part of discal band. Postdiscal area pale cinnamon-rufous with a series of amber-colored round spots. Silvery white lunules present distally in cell Sc + R1, Rs, and Cu2. Extensive yellow scaling present in cell M3 and posterior edge of cell M2. Marginal spots silvery white edged proximally by amber-colored scalings. Fringe uniformly orange. Abdomen: Black covered with pale buff orange hairs, ventrally with extensive pale yellow scaling toward distal end. Genitalia (Figs. 12–15): Sclerites of 9th + 10th segments ring-shaped with a medial triangular membranous area dorsad. Uncus narrow, elongate, bifurcate distally. Saccus broad, short. Valva broad, somewhat rectangular in shape; ampulla elongate with minute teeth dorsad, forming downcurved arm with a wart-like dorsal process at basal  $\frac{1}{4}$ ; harpe simple, setose, with distal end nearly straight; cucullus forming a prominent, densely setaceous triangular tooth dorso-distally. Phallus stout, short, with phallobase about as long as aedeagus. Distal end of vesica forming two vertical semicircular lobes; both lobes spinulose externally but asymmetrically. Bulbus ejaculatorius subterminal. Juxta forming thin, flat lobe with deep dorsal cleft mesad.

**Female.** Unknown.

**Diagnosis.** *B. pales yangi* Hsu & Yen is similar to *B. pales palina* Fruhstofer (Figs. 4, 5) of western China, but differs from it by the following characters: 1) discal spots broader than postdiscal spots on forewing upperside,

2) fringe uniformly colored instead of checkered, 3) basal area of hindwing underside without yellow scaling.

**Biology.** Host plant and early stages in Taiwan unknown. Larvae of populations in Europe utilize *Viola* spp. (Violaceae) (Higgins & Riley 1983). According to Wang and Huang (1993), 15 *Viola* species are known to occur in Taiwan with six species found in the vicinity of the type locality of *B. pales yangi*.

**Type data.** Holotype: ♂, 24°15'N, 121°14'E. TAIWAN: [Taichung Hsien], Lishan, 10.V.1964. Coll. C.T. Yang; paratype: 1♂, same data as holotype. Both holotype and paratype deposited in the Insect Museum, National Chung-Hsin University, Taichung, Taiwan, R.O.C. (NCU).

Comparative material was from the collections of the Natural History Museum, London, U.K. (BMNH), Insect Museum, National Taiwan University, Taipei, Taiwan, R.O.C. (NTU), and NCU.

## DISCUSSION

The population of *B. pales* in Taiwan appears more closely related to those in western China than to those in central Asia and Europe. Two possible synapomorphies shared by the specimens from Taiwan and western China are: 1) Reduced yellow scaling at basal area on hindwing underside (Figs. 3, 5); 2) ampulla of valva narrow with the dorsal process wart-like, present at basal  $\frac{1}{4}$ , abruptly narrowed down toward the base (Figs. 15, 16). The specimens of *B. pales* from central Asia (Figs. 6, 7) and Europe (Figs. 8, 9), as well as *B. napaea* (Hoffmannsegg) (Figs. 10, 11), the sister species of *B. pales*, all have extensive basal yellow scaling on hindwing underside (Figs. 7, 9, 11) and a robust ampulla on which a large dorsal process is present at basal  $\frac{1}{2}$  and attenuates toward the base (Figs. 17, 18; for *B. napaea* see Higgins 1975).

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